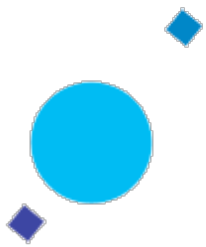


INAF



ISTITUTO NAZIONALE DI ASTROFISICA
NATIONAL INSTITUTE FOR ASTROPHYSICS

INAF



ISTITUTO DI RADIOASTRONOMIA

The Italian VLBI network and the validation of SRT: first tests and perspectives

Matteo Stagni - IVTW - Gröningen (Netherlands) 12-11-2014

Italian baselines

- Mc - Nt - Mt baselines for Geodetic experiments
- Mc - Nt - SRT baselines for Astronomical experiments
- Shortest baseline 500 km
- Longest baseline 900 km









SRT

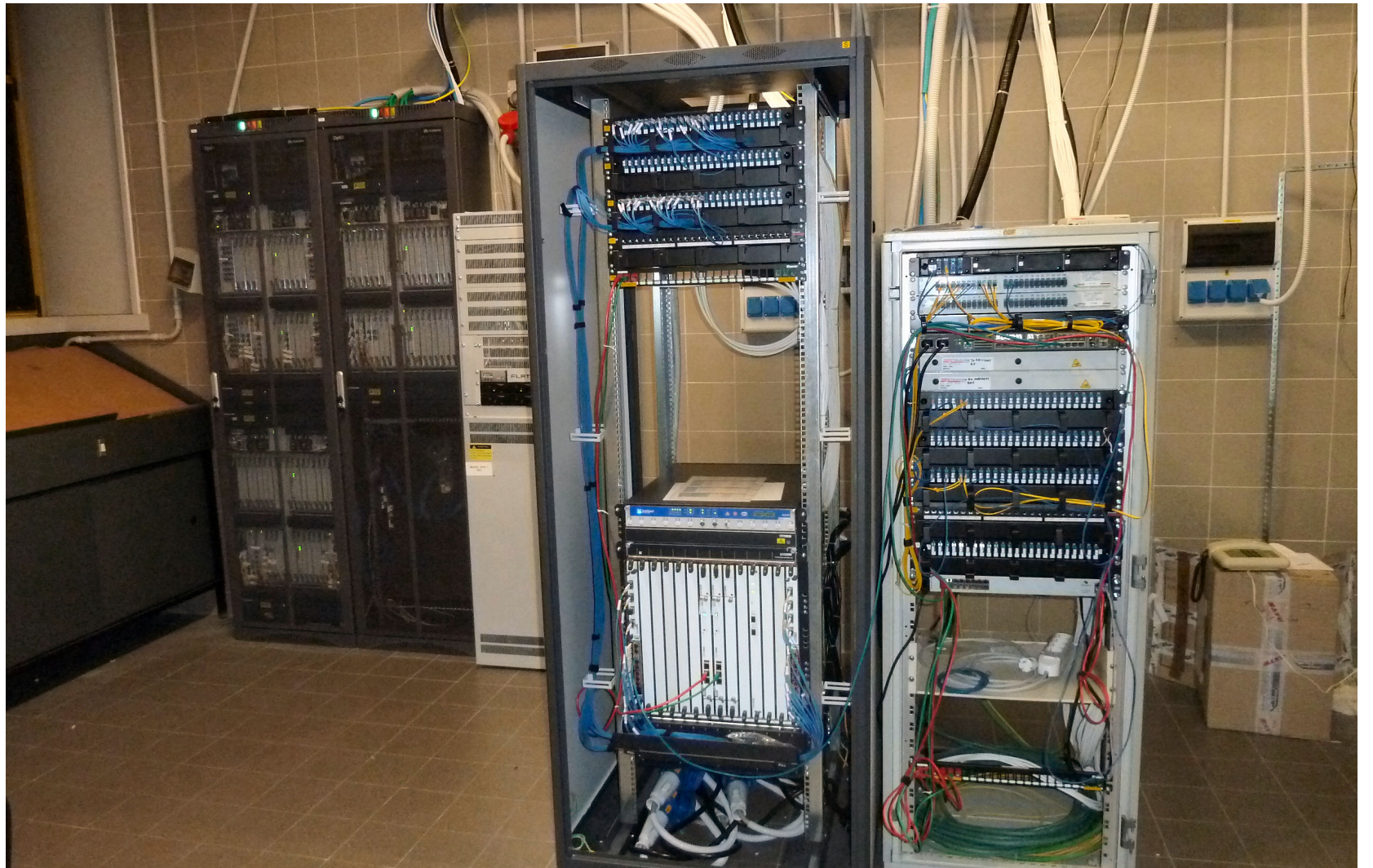
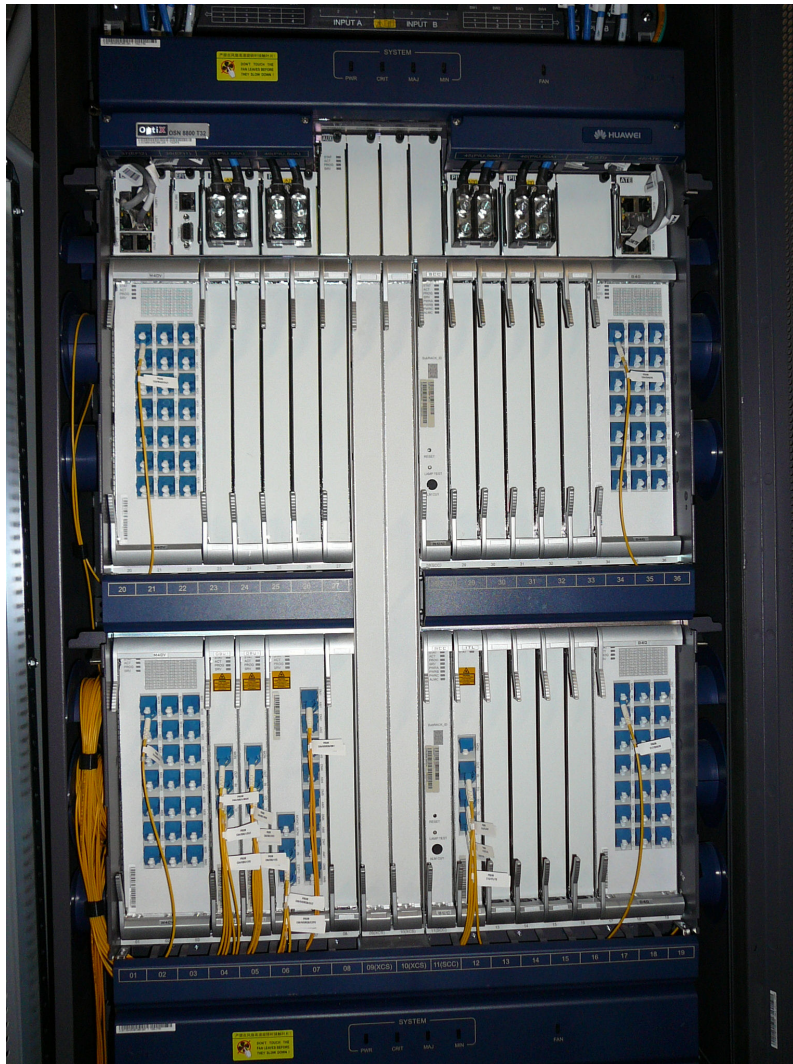
64 mt diameter antenna
Active surface
0.3 -- 100Ghz
high tracking speed

cm	GHz	Resolutive power (arcsec)			
		Medicina	Noto	SRT	VLBI - IT
18	1,6	1474	1474	731	0,02
6	5	472	472	234	0,007
5	9	262	262	130	0,004
2.4	13	181	181	90	0,003
1.3	23	103	103	51	0,002

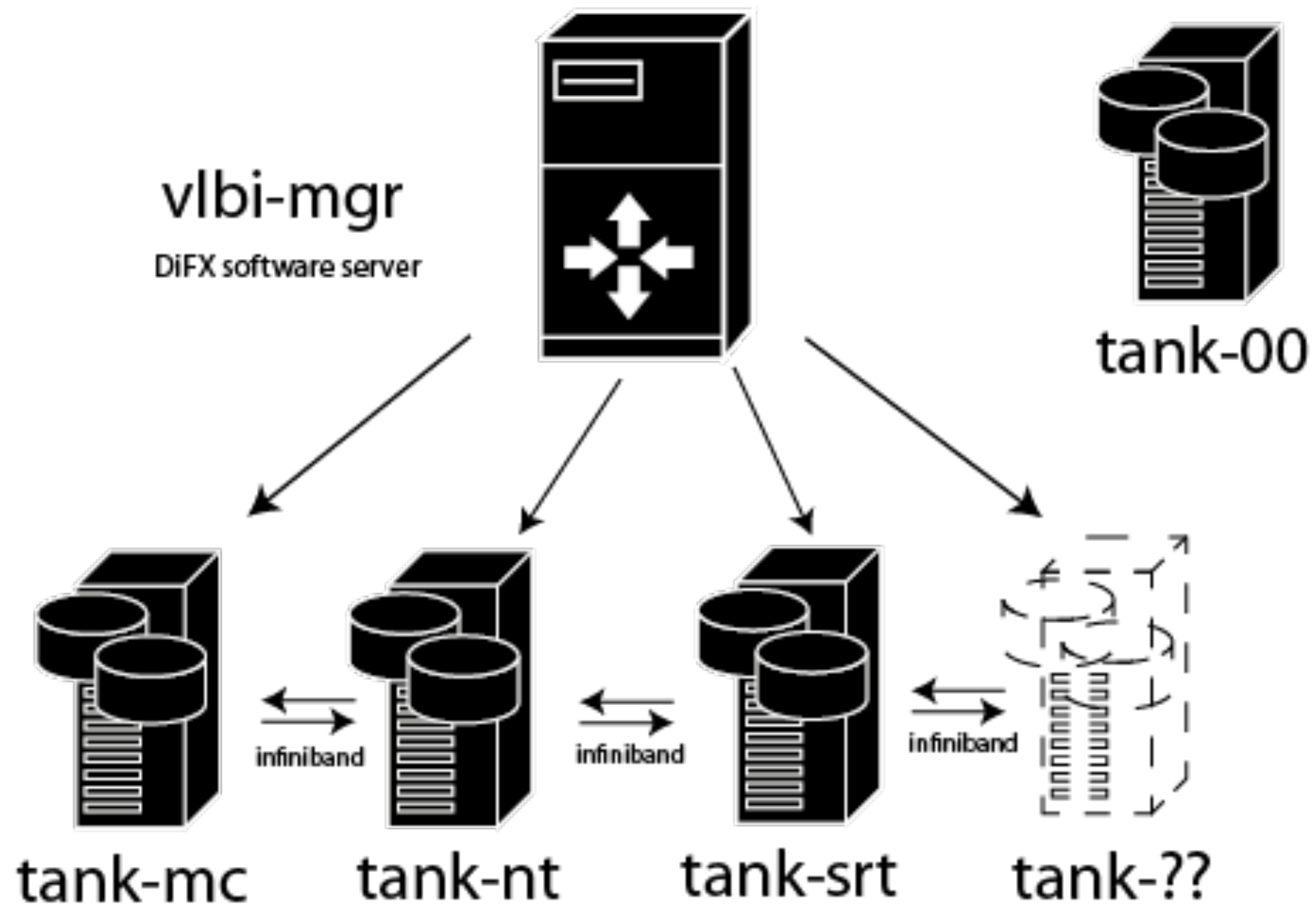
	Antenna	Now	2015	2016
	Mc - 32 mt	10 Gbit/s	10 Gbit/s	10 Gbit/s
	Nt - 32 mt	10 Gbit/s	10 Gbit/s	10 Gbit/s
	SRT - 64 mt	-	-	10 Gbit/s (?)
	IRA - HQ	3 x 10 Gbit/s	3 x 10 Gbit/s	3 x 10 Gbit/s

Garr -> Geant now 2 x 40 Gbit/s

Band on Demand to EVN



Juniper POP and Huawei Lambda DWDM devices



Cluster Architecture

A dedicated storage node for each antenna

Cluster view

Infiniband connection

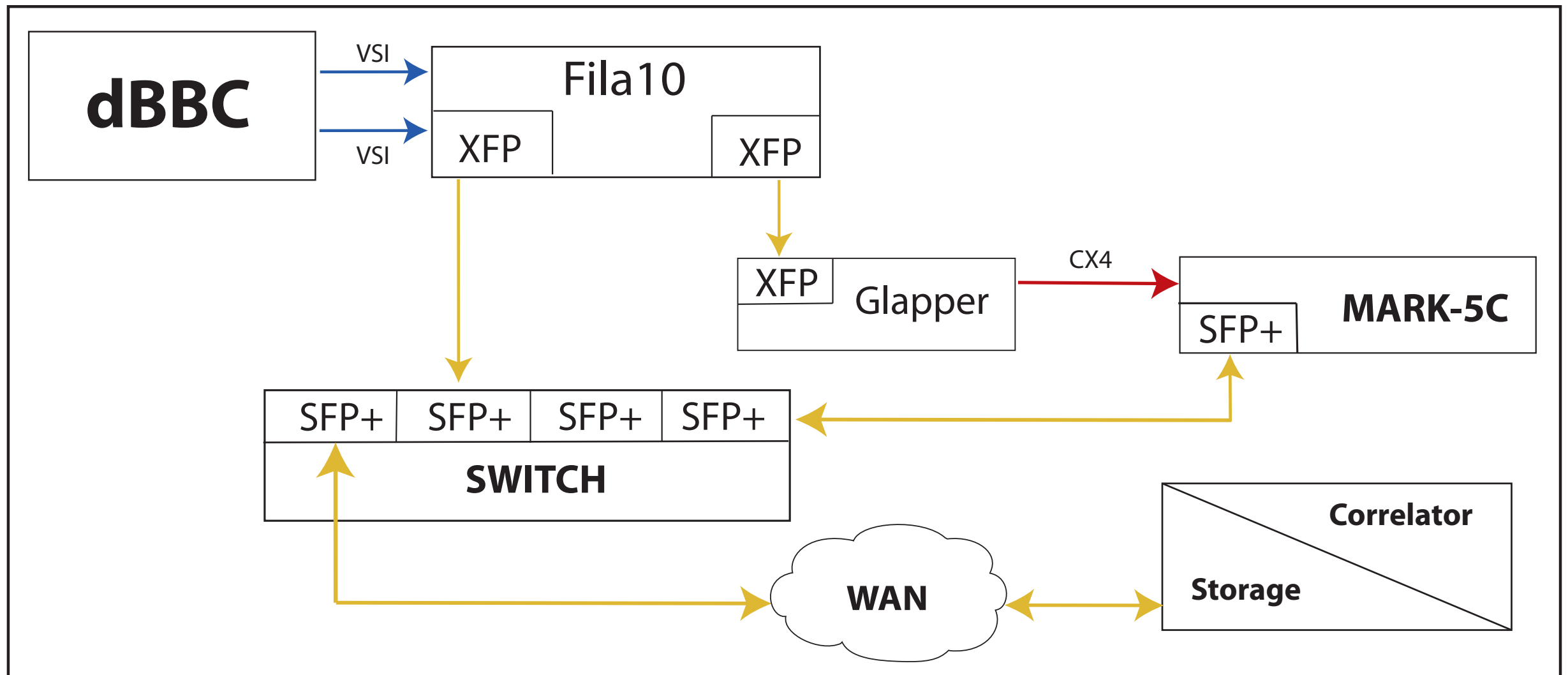
10 Gbit network

24 disks bay

Now 150 TB available

(20 TB SATA + 30 TB SAS each)





Network layout at stations

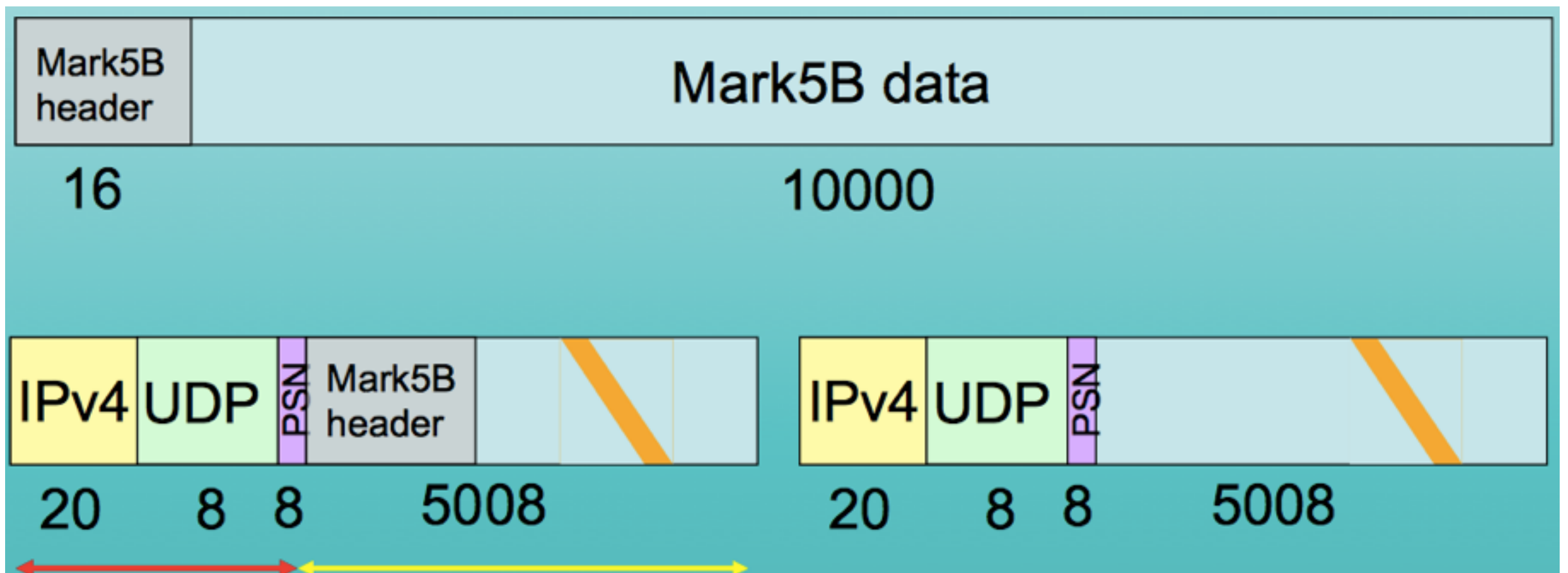
Fila 10 G

- The Fila board (**F**irst - **L**ast) is connected to the dBBC backend through a VSI cable and transfers the data onto an optical fiber adding a Mark5B or VDIF header acting as a formatter



Mark5B data format

Data in Mark5B format has some network problems ...



Jive5ab solves the problem by reassembling packets ...

1 hr recording test @ 4 Gbit Medicina -> Bologna

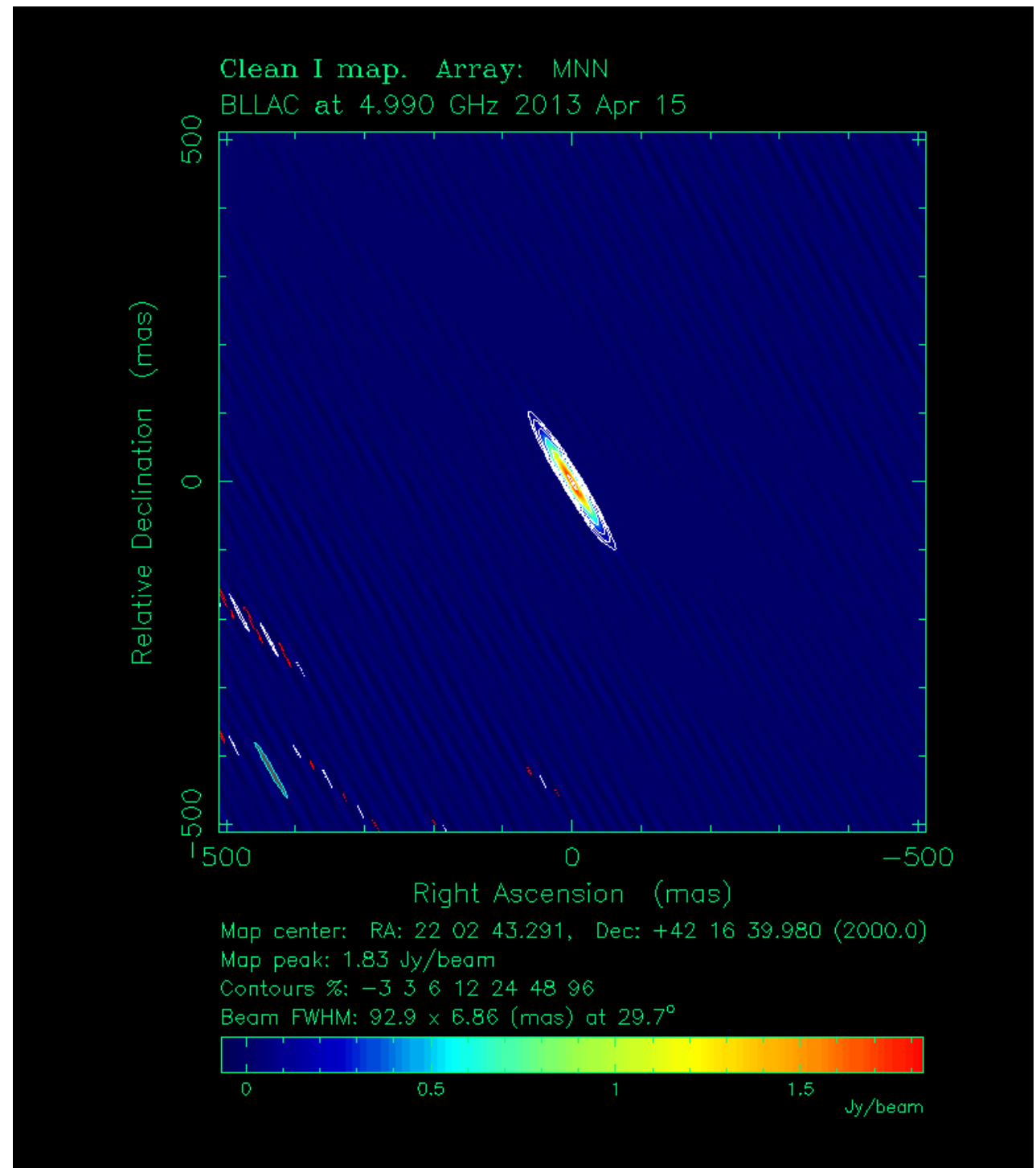
5008 bytes Mark5B - Fila 10 G split packets	SATA RAID 20 TB	SAS RAID 30 TB
Lost packets	5102688	56782
Total packets	363651840	369577856
% lost	1.4 %	0.01 %

Thanks to Harro Verkouter's **jive5ab**

Name	Band	Date	Result	Rec Speed	Mc	Md	Nt	Nd	SRT	Notes
3C84	L	15/3/2013	NO	512	X		X	X		Fringes Nt-Nd
ITVLBI	L	17/3/2013	NO	512	X		X			
apr-15	C	16/4/2013	OK	512	X		X	X		First Fringes Mc - Nt
ivlbi	X	12/10/2013	NO	512	X	X		X	X	Fringes on few scans Mc-Md-Nd
nov25	K	28/11/2013	NO	1024		X		X		Clock problems Md
dec5	X	7/12/2013	NO	1024		X			X	Clock problems Md-SRT
dec17	L	17/12/2013	NO	1024		X		X		Clock problems Md
ivlbi	X	3/1/2014	OK	512	X	X				
temp2	L	13/1/2014	OK	1024		X		X		Fringes Md-Nd-Hh / Nd + 1sec
test5	K	27/1/2014	OK	1024		X			X	First Fringes SRT
test5	K	4/2/2014	OK	1024		X			X	New position SRT
l128	L	18/2/2014	OK	128		X			X	
l1024	L	19/2/2014	NO	1024					X	Clock problems Md-SRT
l512	L	19/2/2014	NO	512		X			X	Clock problems Md-SRT
test10	X	28/2/2014	NO	512		X			X	No fringes SRT
r4620	S/X	19/3/2014	OK	512	X	X				Strong Fringes CTA26 streaming from Md to Bologna
1313	C	28/3/2014	OK	512	X	X		X		Australian campaign
ap30b	C	30/4/2014	NO	1024				X	X	Autocorrelation Nd-Nd streaming only p_cal
3c161	C	15/5/2014	OK	512	X	X		X		Test on 3c161
taurusa	X	15/5/2014	OK	1024	X	X				Transient test Md streaming to Bologna
may23	L	23/5/2014	NO	512	X	X			X	Mc-Md streaming only p_cal

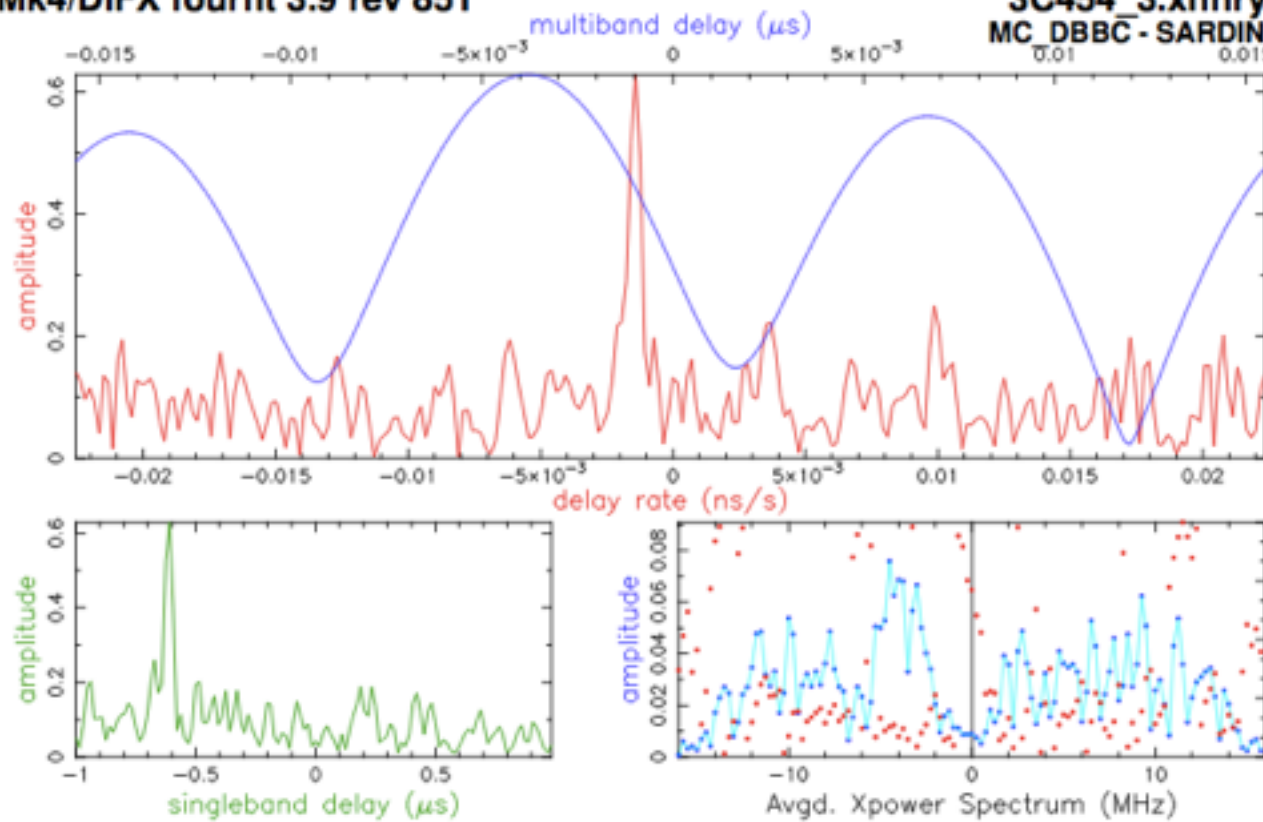
First test

- Medicina - Noto baseline
- 15-04-2013



Mk4/DiFX fourfit 3.9 rev 851

3C454_3.xhnryu, No0004, LW
MC_DBBC - SARDINIA, fgroup K, pol RR



Fringe quality 9
 Error code H
 SNR 8.5
 Int time 96.000
 Amp 0.637
 Phase -131.2
 PFD 9.6e-11
 Delays (us)
 SBD -0.612395
 MBD -0.003638
 Fringe rate (Hz)
 -0.032891
 Ion TEC 0.00
 Ref freq (MHz)
 22187.4900
 AP (sec) 1.000
 Exp. test5
 Exper # 16383
 Yr:day 2014:027
 Start 123604.00
 Stop 123740.00
 FRT 123650.00
 Corr/FF/build
 2014:026:164637
 2014:027:164515
 2013:290:053232
 RA & Dec (J2000)
 22h53m57.7479s
 +16°08'53.561"

Amp. and Phase vs. time for each freq., 48 segs, 2 APs / seg (2.00 sec / seg.), time ticks 2 sec

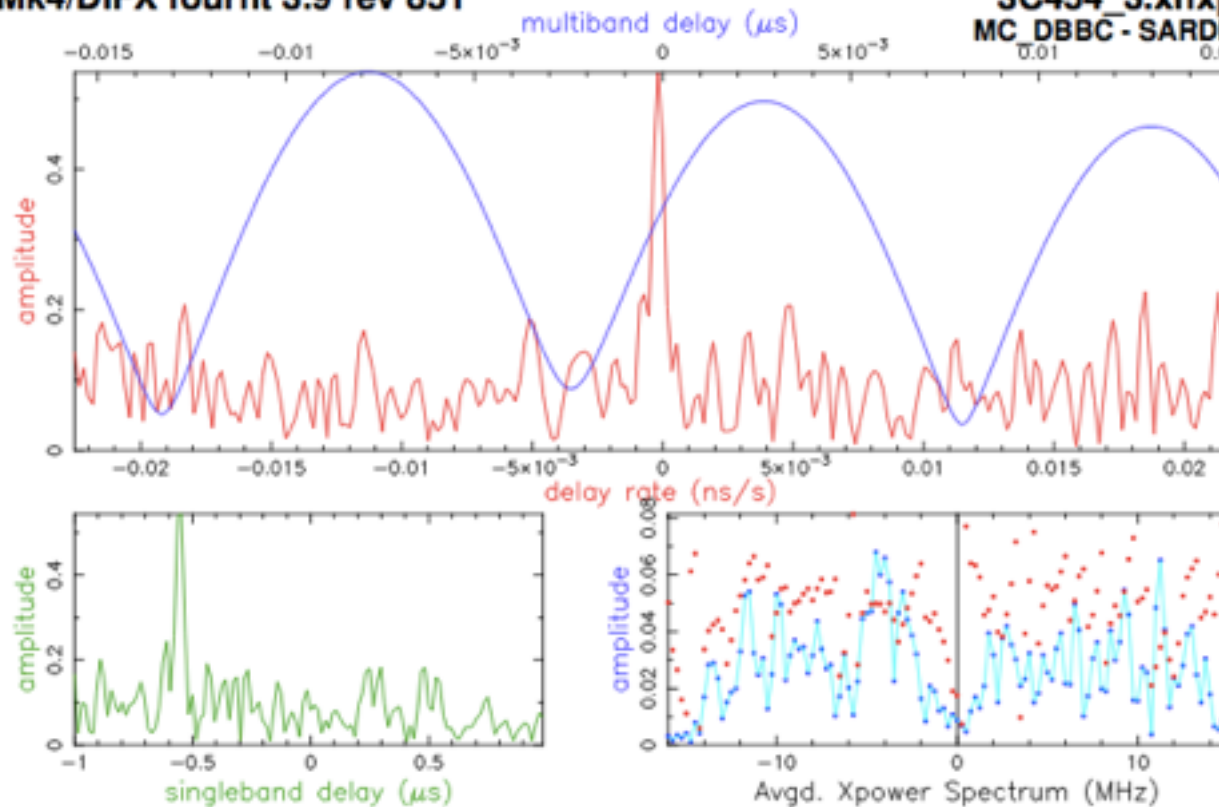
SRT position
measured
more
accurately
after the first fringe

Delay reduced by
0.1 μsec



Mk4/DiFX fourfit 3.9 rev 851

3C454_3.xhxpjp, No0004, LW
MC_DBBC - SARDINIA, fgroup K, pol RR



Fringe quality 9
 Error code H
 SNR 7.9
 Int time 96.000
 Amp 0.586
 Phase 38.9
 PFD 2.1e-08
 Delays (us)
 SBD -0.554420
 MBD -0.008194
 Fringe rate (Hz)
 -0.005832
 Ion TEC 0.00
 Ref freq (MHz)
 22187.4900
 AP (sec) 1.000
 Exp. test5
 Exper # 16383
 Yr:day 2014:027
 Start 123604.00
 Stop 123740.00
 FRT 123650.00
 Corr/FF/build
 2014:034:180724
 2014:035:180715
 2013:290:053232
 RA & Dec (J2000)
 22h53m57.7479s
 +16°08'53.561"

Amp. and Phase vs. time for each freq., 48 segs, 2 APs / seg (2.00 sec / seg.), time ticks 2 sec

Weather problems
in Sardinia

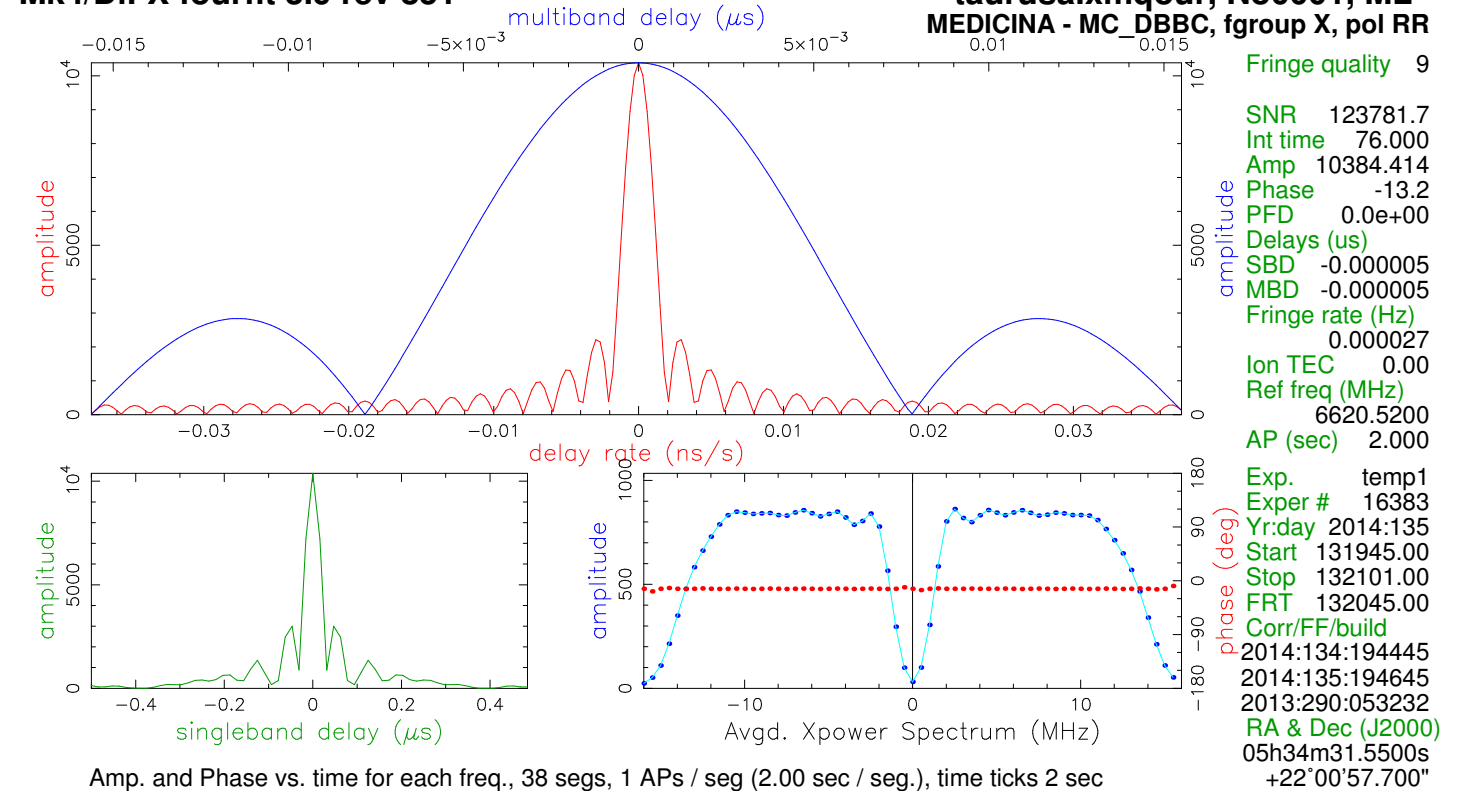


Medicina dBBC
streaming to Bologna
@ 1 Gbit
while recoding with
Mark5C at the station

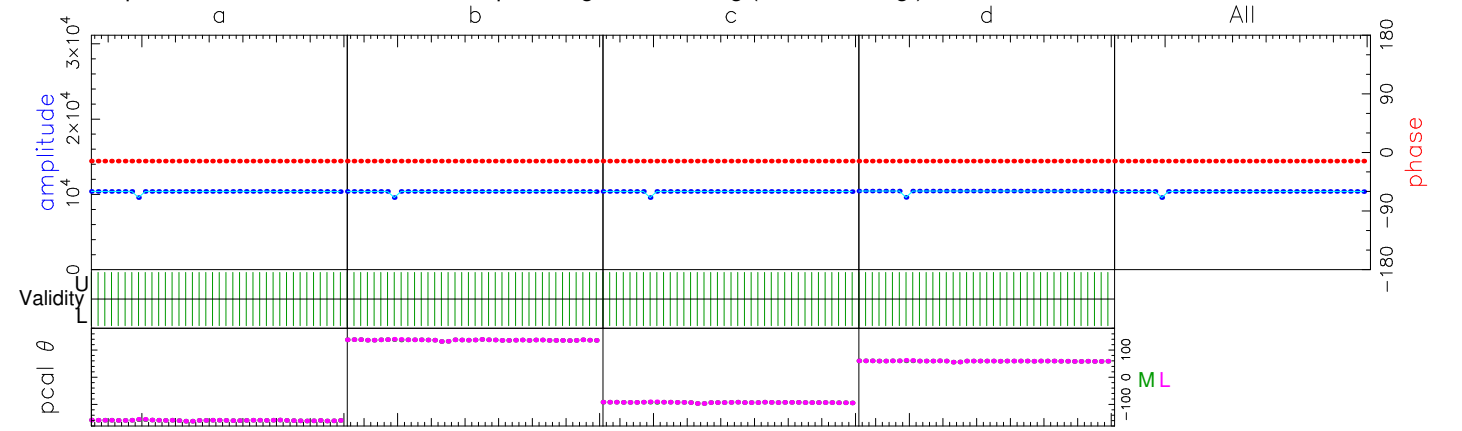
Taurus A passing over
a **stopped** antenna...

Mk4/DiFX fourfit 3.9 rev 851

taurusa.xmqour, No0001, ML
MEDICINA - MC_DBBC, fgroup X, pol RR



Fringe quality 9
SNR 123781.7
Int time 76.000
Amp 10384.414
Phase -13.2
PFD 0.0e+00
Delays (us)
SBD -0.000005
MBD -0.000005
Fringe rate (Hz) 0.000027
Ion TEC 0.00
Ref freq (MHz) 6620.5200
AP (sec) 2.000
Exp. temp1
Exper # 16383
Yr:day 2014:135
Start 131945.00
Stop 132101.00
FRT 132045.00
Corr/FF/build 2014:134:194445
2014:135:194645
2013:290:053232
RA & Dec (J2000) 05h34m31.5500s +22°00'57.700"



	6620.52	6652.52	6684.52	6716.52	Freq (MHz)	All
	-13.2	-13.2	-13.2	-13.2	Phase	-13.2
	10384.6	10364.1	10374.1	10414.8	Ampl.	10384.4
	33.0	33.0	33.0	33.0	Sbd box	33.0
U/L	38/38	38/38	38/38	38/38	APs used	
M	1480	1480	1480	1480	PC freqs	
L	1480	1480	1480	1480	PC reqs	
M:L	116:116	-129:-129	-33:-33	91:91	PC phase	
M:L	0:0	0:0	0:0	0:0	ManI PC	
M	35	33	36	32	ManI PC	
L	35	33	36	32	ManI PC	
M	X00UR,X00LR	X01UR,X01LR	X02UR,X02LR	X03UR,X03LR	Chan ids	
L	X00UR,X00LR	X01UR,X01LR	X02UR,X02LR	X03UR,X03LR	Tracks	
					Chan ids	
					Tracks	
Group delay (usec)	2.67591944068E-07	Apriori delay (usec)	5.58009194407E-06	Resid mbdelay (usec)	-5.31250E-06	+/- 3.6E-08
Sband delay (usec)	5.80091944068E-07	Apriori clock (usec)	0.0000000E+00	Resid sbdelay (usec)	-5.00000E-06	+/- 1.4E-07
Phase delay (usec)	3.16403082114E-08	Apriori clockrate (us/s)	0.0000000E+00	Resid phdelay (usec)	-5.54845E-06	+/- 1.9E-10
Delay rate (us/s)	-1.50216366286E-09	Apriori rate (us/s)	-4.09225084263E-09	Resid rate (us/s)	2.59009E-09	+/- 8.9E-12
Total phase (deg)		Apriori accel (us/s/s)	7.90787509034E-14	Resid phase (deg)	-13.2	+/- 0.0
	RMS	Theor.	Amplitude	10384.414 +/- 0.084	Pcal mode: NORMAL, NORMAL	Pcal period (AP's) 9999, 9999
ph/seg (deg)	0.0	0.0	Search (128X16)	10384.332	Pcal rate: -9.962E-09, -1.143E-08 (us/s)	sb window (us) -0.500 0.500
amp/seg (%)	1.3	0.0	Interp.	0.000	Bits/sample: 2	SampCntNorm: disabled
ph/frq (deg)	0.0	0.0	Inc. seg. avg.	10384.413	Sample rate(MSamp/s): 32	mb window (us) -0.016 0.016
amp/frq (%)	0.2	0.0	Inc. frq. avg.	10384.413	Data rate(Mb/s): 512	dr window (ns/s) -0.038 0.038
					nlags: 32	t_cohere infinite
						ion window (TEC) 0.00 0.00
M: az 181.2 el 67.5 pa 0.9	L: az 181.2 el 67.5 pa 1.4	u,v (fr/asec)	-0.000 0.000			simultaneous interpolator
Control file: control	Input file: /space1/realtime2/1234/No0001/ML..xmqour	Output file: Suppressed by test mode				

Mark5B header

SYNCWORD + FRAME # + MJD (3) + SEC FROM 00:00 + μ SEC

Fila 10 G formatter

ABADDEED *	0	81259812	00000000
ABADDEED *	1	81259812	00000000
ABADDEED *	2	81259812	00000000
ABADDEED *	3	81259812	00000000
ABADDEED *	4	81259812	00000000
ABADDEED *	5	81259812	00000000
ABADDEED *	6	81259812	00000000
ABADDEED *	7	81259812	00000000
ABADDEED *	8	81259812	00000000
ABADDEED *	9	81259812	00000000

Mark5B+ formatter

ABADDEED	0	81259773	00005CD6
ABADDEED	1	81259773	00035CDC
ABADDEED	2	81259773	00065CC2
ABADDEED	3	81259773	00095CE0
ABADDEED	4	81259773	00125CBA
ABADDEED	5	81259773	0015DCAB
ABADDEED	6	81259773	00185C86
ABADDEED	7	81259773	00215C10
ABADDEED	8	81259773	0025DC0B
ABADDEED	9	81259773	00285C26

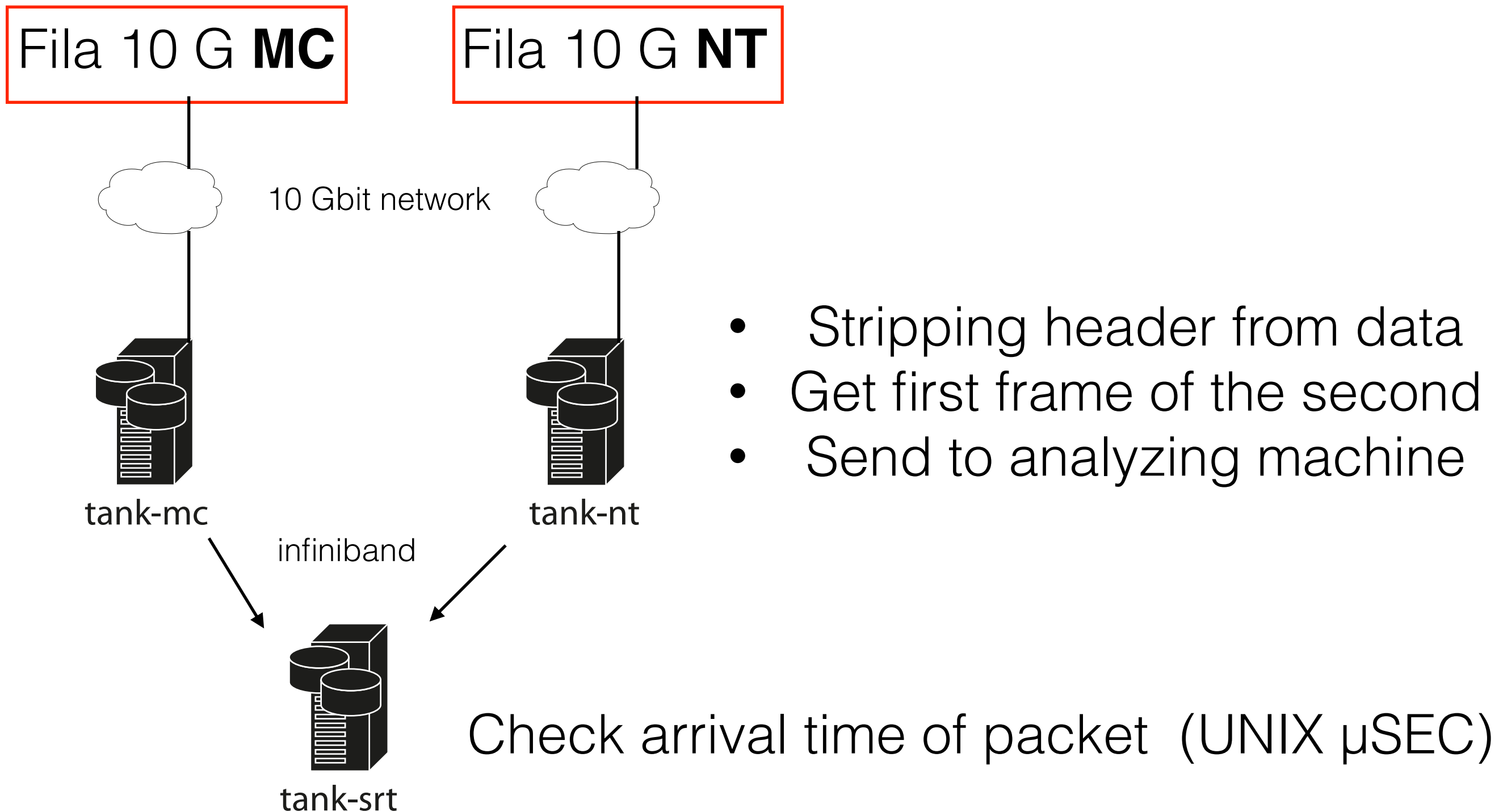
TIMESYNC

- Fila 10 G fromatter needs manual timesync command from operator to sync to PPS coming from dBBC VSI cable
- Issues about when to press the enter button
- How to track time slips without μsec in headers?

vlbiTimeServer

- Analyze data headers in real time coming from the antenna
- Quicker than organizing a proper observation
- No need to record any data
- Can run when antennas are down (maintenance)

vbiTimeServer



vlbiTimeServer

- Network delay -> 0.10 **seconds** between Noto and Medicina
- Packets lost - sometimes
- Run continuously over a week @ 1 Gbit and no time slips
- When time slips need to re-sync dBBC FPGA and Fila 10

VDIF

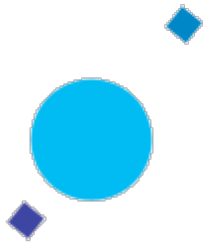
	Byte 3		Byte 2	Byte 1	Byte 0
	Bit 31 (MSB)				Bit 0 (LSB)
Word 0	I_1	L_1	Seconds from reference epoch ₃₀		
Word 1	Un-assigned ₂		Ref Epoch ₆	Data Frame # within second ₂₄	
Word 2	V_3		$\log_2(\#chns)_5$	Data Frame length (units of 8 bytes) ₂₄	
Word 3	C_1	bits/sample-1 ₅	Thread ID ₁₀		Station ID ₁₆
Word 4	EDV ₈			Extended User Data ₂₄	
Word 5	Extended User Data ₃₂				
Word 6	Extended User Data ₃₂				
Word 7	Extended User Data ₃₂				

VDIF

Why NOT ATM?

- Fila 10 G firmware unreliable (switch from big to little endian - compulsory change of thread number at certain sampling speed)
- *Sched* not producing VDIF in VEX files - hand edit
- Station operators not confident enough - new dBBC backends

INAF



ISTITUTO NAZIONALE DI ASTROFISICA
NATIONAL INSTITUTE FOR ASTROPHYSICS

INAF



ISTITUTO DI RADIOASTRONOMIA

Questions?

Matteo Stagni - IVTW - Gröningen (Netherlands) 12-11-2014